THE DISTRIBUTION OF *THECLINESTHES ALBOCINCTA* (WATERHOUSE) AND *THECLINESTHES HESPERIA LITTORALIS* SIBATANI & GRUND, BASED ON HERBARIUM RECORDS OF EGGS (LEPIDOPTERA: LYCAENIDAE)

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Abstract

The distributions of *Theclinesthes albocincta* (Waterhouse) and *Theclinesthes hesperia littoralis* Sibatani & Grund are significantly extended, based on the preservation of their eggs on dried foodplant, *Adriana* Gaudich. (Euphorbiaceae), now preserved within Australian Herbaria.

Introduction

A recent undertaking by the Adelaide Herbarium to revise the genus *Adriana* allowed an opportunity for the author to examine an Australia-wide representative collection of preserved specimens from the Perth, Adelaide, Canberra and Brisbane Herbaria, for evidence of egg laying by *T. albocincta* (Waterhouse) and *T. hesperia* Sibatani & Grund. Unfortunately, *Adriana* material from the Melbourne and Sydney Herbaria had already been returned before the author could undertake the examination.

Currently, genus *Adriana* consists of two complexes (Jessop and Toelken 1986), containing five species all of which are dioecious. The first complex, distinguished by having alternate leaves, contains *Adriana glabrata* Gaudich, *A. hookeri* (F.Muell.) Muell.-Arg., and *A. tomentosa* Gaudich. The second complex is distinguished by having opposite leaves and contains *A. klotzschii* (F.Muell.) Muell.-Arg. and *A. quadripartita* (Labill.) Gaudich.

The distribution of *A. klotzschii* and *A. quadripartita* is the coastal and near coastal sand-hills of southern Australia, including the larger offshore islands (except Bass Strait Islands) (Fig. 1), with *A. quadripartita* confined mainly to Western Australia and *A. klotzschii* solely to South Australia and Victoria. There is an inland extension of *A. klotzschii* to Eyre Peninsula and the Flinders Range and eastward into the Olary Range. *A. hookeri* occurs in the inland arid sand-hill areas of Australia, including north-west Victoria, while *A. tomentosa* occurs in the north-west of Western Australia, particularly along creeklines. *A. glabrata* also occurs along creeklines, in the northern tropical and eastern seaboard and montane areas of Australia. *Adriana* does not occur in Tasmania. The different species do not normally grow together. *Adriana* distribution in Australia (Fig. 1) was compiled from the specimens at the Adelaide Herbarium and from data base listings requested from the Alice Springs, Darwin, Melbourne and Sydney Herbaria.

Previous distributions of *T. albocincta* and *T. hesperia*, based on adult butterfly captures, were very disjointed with isolated populations recognized in south-west Western Australia, several coastal and island localities in north-

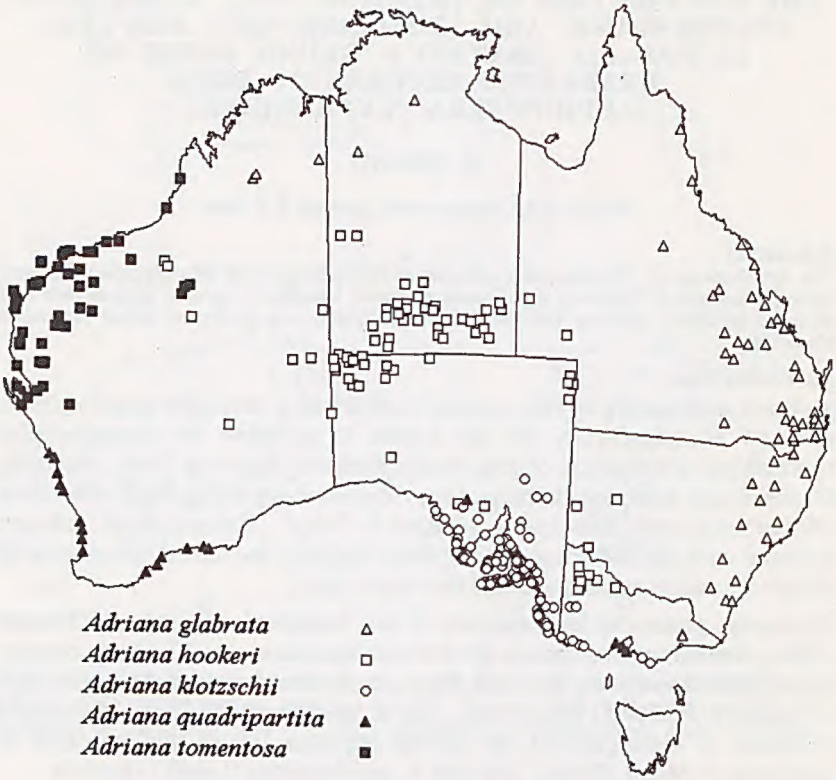


Fig. 1. Distribution of *Adriana glabrata*, *A. hookeri*, *A. klotzschii*, *A. quadripartita* and *A. tomentosa*.

west Western Australia, a couple of localities in central Australia, a broad population in southern South Australia and north-west Victoria, plus the single lectotype male from Peak Downs in Queensland (Fig. 2) (Sibatani and Grund 1978; Fisher 1978, 1985; Common and Waterhouse 1981; Field 1987, 1990; Dunn and Dunn 1991; Douglas and Braby 1992). There is also a male specimen in the Natural History Museum, London labelled 'N. Queensland' which, until now, was thought to be wrongly labelled. Life history records had shown an association of *T. albocincta* with *A. klotzschii* in coastal South Australia and with *A. hookeri* in northwest Victoria, while elsewhere adults were always captured flying near *Adriana*. *T. hesperia* had shown an association with *A. quadripartita*.

Methods and Results

Over 500 dried *Adriana* specimens were examined under binocular magnification, of which 105 specimens had indications of Lycaenid egg

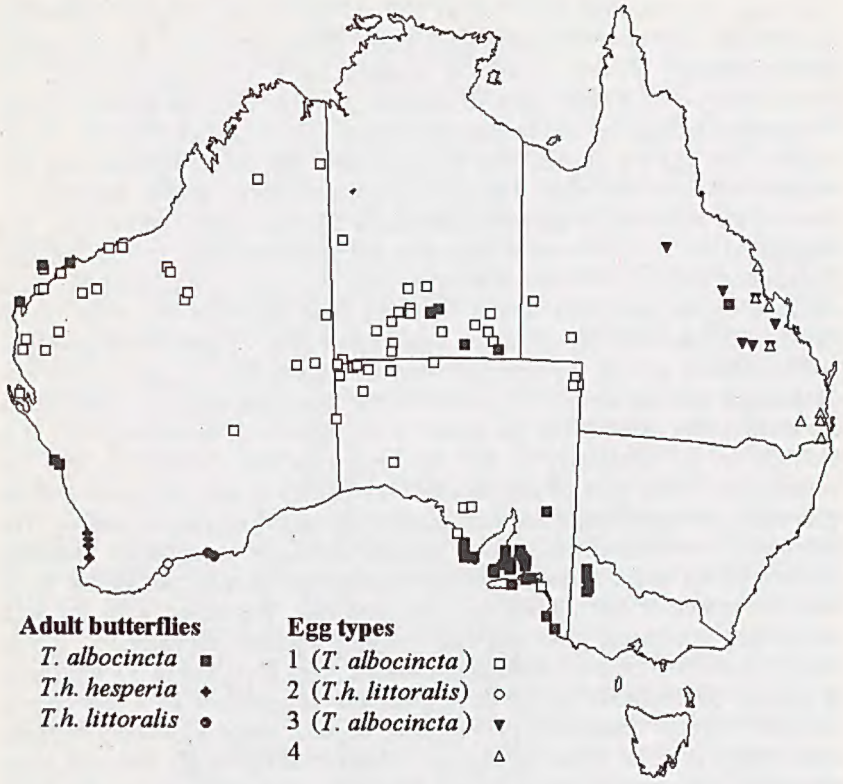


Fig. 2. Distribution of adult captures of *Theclinesthes albocincta, T. h. hesperia*, *T. h. littoralis* and of Egg Type 1 (*T. albocincta*), Type 2 (*T. h. littoralis*), Type 3 (*T. albocincta*), Type 4 on *Adriana* herbaria specimens.

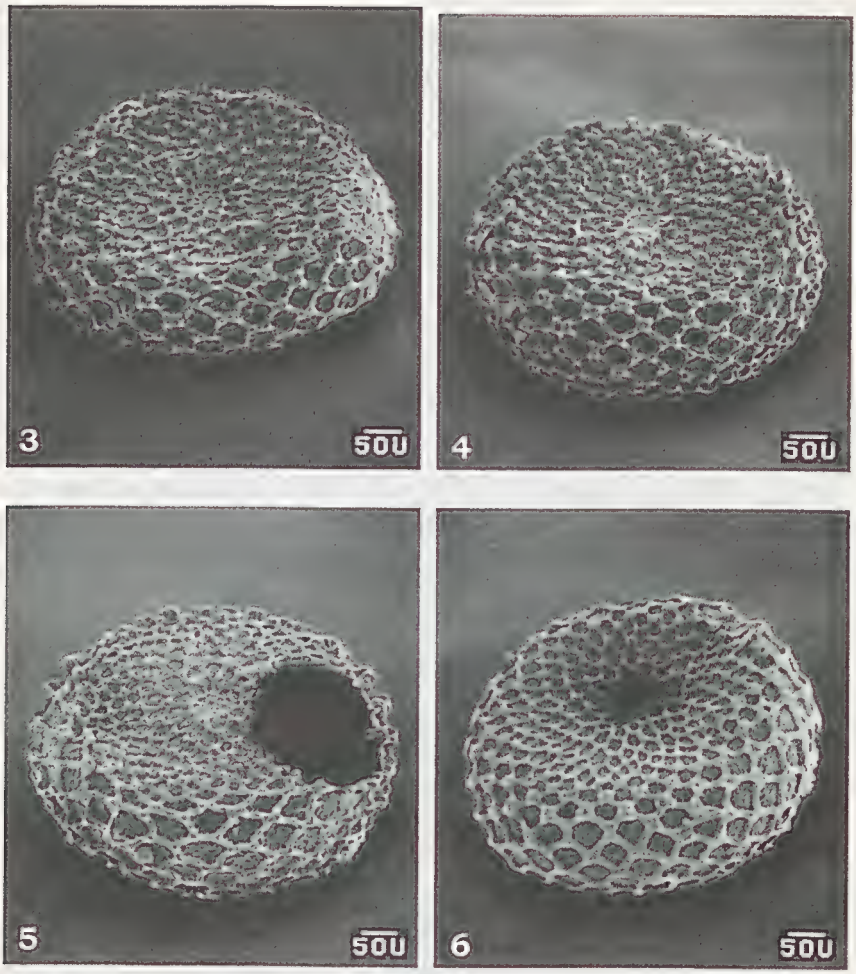
laying. Most of the egg laying activity occurred on the male flowers (where it was sometimes abundant), but eggs were also found on the stems or beneath the leaves on both plant sexes, with subsequent larval activity having produced a scoring of the leaf surfaces. The eggs were laid singly or rarely in twos or threes. Additional evidence of larval boring into the flower buds was often recognized but not recorded in the event that the borings may have been partly due to other insect activity.

Four different egg types were recognized on the *Adriana*, all having Lycaenid character of oblate spheroid shape, the bottom flattened, the top flattened and depressed and a raised reticulated pattern of varying ornateness on the surface. The first and most common egg type is attributed directly to *T. albocincta* (as it is currently understood). It occurred on all the *Adriana* species, in Western Australia, central Australia, South Australia and north-west Victoria (Fig. 2).

This egg, illustrated in Figs 3-6, is defined by having a regular spiralling, rhomboid, reticulated pattern with thick blunt processes at the pattern intersections. These processes were usually strongly elevated but occasionally (Fig. 6) they were ill defined. Rarely, when the pattern became irregular, a hexagonal and pentagonal reticulation occurred (Fig. 5). On the sides of the egg the pattern area is quite coarse but on the flattened top it is smaller and more irregular. The intra-reticulated chorion area is dimpled. To the eye the reticulation appears fused to the chorion. Egg Type 2 (Fig. 7) is attributed to *T. h. littoralis* and was encountered only in the Albany-Esperence area of Western Australia (Fig. 2), on *A. quadripartita*. It is defined by its similarity to the first egg type but with the relief of the ornamentation markedly reduced. Egg Type 3 (Fig. 8) was found mainly in the hinterland area of the central Queensland coast (Fig. 2), on *A. glabrata*, associated with the area of occurrence of the lectotype male of *T. albocincta*. Its distribution extended to the coast in the vicinity of Rockhampton. It is defined by its similarity to the first egg type but differed in that the reticulation forms part of the chorion, the pattern is not as coarse and the processes are more consistently developed, especially on the top surface. The intra-reticulated areas are porous looking and have an apparent radiating surface which under normal light microscopy was usually not visible but it had the effect of diffracting the light and this, combined with the well developed processes, gave the egg a sugary opaline appearance. It was usually found on the male foodplant flowers. Egg Type 4 (Fig. 9) was found in coastal Queensland (Fig. 2), on *A. glabrata*. It is defined by a very coarse, irregular trigonal reticulated pattern, each trigonal shape ultimately merging with others to form larger hexagonal shapes, with strongly elevated blunt processes at the pattern intersections. The intra-reticulated area is smooth. It was usually found on the leaf undersides of male foodplants. This egg is not of typical *Theclinesthes* character, having a form very similar to *Zizina labradus* (Godart), although this butterfly is not known to use foodplants outside of the Leguminosae/Papilionoideae family. Common and Waterhouse (1981) state that *Philiris nitens nitens* (Grose-Smith) and *Arhopala micale amphis* Waterhouse use *Glochidion* spp, a plant genus related to *Adriana* in the Euphorbiaceae and therefore these eggs may belong to either of these species, although the author is not familiar with their eggs. At Banana and Yatton Creek, Egg Types 3 and 4 were found together on the same plants.

It is recognized that the above data should be used with caution (Kitching and Zalucki 1983), hence the use of (likely) as a suffix to the following egg types and the assumption is that *T. albocincta* and *T. hesperia* are restricted to *Adriana* for foodplants. The bracketed suffix to the distribution records on *Adriana* refers to the state herbarium (A=Adelaide, B=Brisbane, C=Canberra, P=Perth), its reference number and the year of sampling.

Egg records on the *Adriana* material examined:
Egg Type 1 (*T. albocincta* likely): **Western Australia** on *A. hookeri*: Sir Frederick Range (P.ex NT34904, A.97228090-1972); East of Gregory Range on Rabbit Proof Fence approx. 21°24'-121°18' (P. Royce 1887-1947); 35 km N of Lookout Rocks on R.P.F. approx. 21°38'-121°24' (P. Royce 1840-1947); between Cavanagh and Blackstone Ranges (P.George 5262-1963); 59km E Warburton Mission (C.196249-1960); 320 km NE Kalgoorlie, Victoria Desert Camp 54 (Elder Expedition) (A.96832164-1891); on *A. tomentosa*: Peron Peninsula (P. Blackall 4662-1940); Minilya (A.971030023-1969) (P. Ashby 2934-1969); 35 km N Minilya (P.33173, C.209696-1967); Williambury Stn, Kennedy Range (P. Cranfield 1915-1981); Manberry Stn 24°02'-114°09' (P. Gardner 3029-1932); Henry River, Barlee Range (P. Royce 6534-1961); Onslow (P. Pfeiffer-1977); 20 km E Onslow (C.297493-1979); Barrow Island (P. Butler 104-1973); 22 km NE Fortescue (A.97810436-1977); between Coolawanyah and Hamersly Stations, Hamersly Range (P. Blockley 339-1966); Mt Margaret, Hamersly Range (P. Gardner 3133-1932); Rudall River 22°35'-122°10' (P. Wilson 10305, A.98837039-1971); between Lake Disappointment and Robertson Range (P. Royce-1973); Port Hedland (P.George 1100-1960); DeGrey River (P. Burbidge 1145-1940): on *A. glabrata*: Geikie Gorge (A.96808313, P. Bennett 1959-1967); Ord River Gorge (P. Gardner 7330-1944). **Northern Territory** on *A. hookeri*: Mann Range, 35 km NE Mt Davies Camp (P.ex NT28867-1970); Mt Conner Hstd (A.97342248, A.97342249-1973); 65 km N Uluru (A.97407001-1935); George Gill Range, Bagot Springs Ck, 32 km E Kings Canyon (C.225618-1966); Curtin Springs Hstd (A.97615070-1974); 12 km NW Areyonga (A.97017062-1968); 40 km W Hermannsburg (A.96242275-1954); Palm Valley (A.96216027-1954); 48 km SSW Alice Springs on Stuart Hwy (B.376110, C.264050-1977); 43 km SSW Alice Springs (C.33042-1954); 39 km SSW Alice Springs (A.96002077, C.92911-1956); 35 km SSE Aileron (A.96942067-1969); NW Stock Route, 3 km NW Desert Bore approx. 23°06'-132°46' (A.98935008, B.231378-1950); 21 km NW Desert Bore, Hamilton Downs approx. 23°00-132°40 (C.63477-1955); 11 km SW Inningarra Range 20°50'-129°37' (A.97049475-1970); 48 km SE Alice Springs (A.95952029-1956); Bundooma (A.98031072-?); NW Simpson Desert 24°34'-135°51' (C.331189-1982); NW Simpson Desert 24°03'-136°34' (A.97615252-1973); Simpson Desert 25°15' 50" 136°43'35" (A.96733058, A.96733059-1966); Simpson Desert 24°53'-136°30' (A.96832166-1959). **Queensland** on *A. hookeri*: 3 km S Carlo, East Simpson Desert approx. 23°28'-138°40' (B.232978-1977); 19 km SE Monkira 24°57'-140°31' (B.247284-1978). **South Australia** on *A. hookeri*: Cordillo Downs 26°42'-140°47' (A.96806449-1924) (A.97916052-1963); near junction Montkeleary and Dripie Cks 27°02'-140°41' (A.97539292, A.97539293-1975); 9 km N Leap Year Bore 26°59'-140°57' (A.98828229-1988); 9 km NE Leap Year Bore 27°04'-140°57' (A.98425595-



Figs 3-6. SEM photographs of Egg Type 1 (*T. albocincta* likely) collected from herbaria specimens of *Adriana*: (3) Ooldea, SA; (4) Musgrave Range, SA; (5) Minilya, WA; (6) Geikie Gorge, WA.

1976); Marqualpie Paddock, Innamincka Regional Reserve approx. 26°54'-140°49' (A.99136051-1991); Tieyon Stn 26°12'-133°51' (A.98024004-1973); Mt Harriet Rd, 35 km S Musgrave Park Station, Musgrave Range (A.96648124-1966); 18 km NE Deering Hills (A.97840262- 1978); 15 km NE Mt Cooperinna (A.97843097-1978); Spinifex Camp, Deering Hills 26°19'-129°53' (A.97904018-1955); Tomkinson Range (A.96806448-1954); 18 km NE Mt Kintore 26°27'-130°37' (A.97844336-1978); 6 km ENE Mt Moulden (A.97845188-1978); 5 km SE Cheessman Junction

Figs 7-9. SEM photographs of lycaenid eggs collected from herbaria specimens of *Adriana*: (7) Egg Type 2 (*T. h. littoralis* likely), Fitzgerald R., WA; (8) Egg Type 3 (*T. albocincta* as lectotype likely), Banana, Qld; (9) Egg Type 4, Yatton Creek, Qld.

(A.97838080-1978); near Serpentine Lakes 28°31-129°00 (A.98535048-1979); Ooldea Soak (A.96806447-1939) (C.70375-1956); Thurlga Gate, Gawler Range (A.96942367-1969); Scrubby Peak, Gawler Range (A.97934059-1967); on *A. klotzschii* (known adult butterfly localities not recorded): Elliston (A.96805518-1967); SE Meningie, N side of Coorong

(C.242135-1965).

Egg Type 2 (*T. h. littoralis* likely): **Western Australia** on *A. quadripartita*: Bremer Bay (P.Aplin 2772-1963); near mouth Fitzgerald River Inlet (P. Aplin 3649-1970); Esperance (P. Royce 6315-1960).

Egg Type 3 (*T. albocincta* lectotype likely): **Queensland** on *A. glabrata*: Bauhinia Downs (B.284623-1968); 20 km SE Rolleston on Duaringa Hwy (B.249307-1978); Banana (C.107447-1961); Warren State Farm (B.360204-?); Yatton Ck near Croydon, 93 km NW Marlborough (B.191925-1973); 50 km N Clermont (B.305959-1983); Bullock Ck, 65 km E of Hughenden (B.360207-?).

Egg Type 4: **Queensland** on *A. glabrata*: Between Spring Bluff and Murphys Ck (B.360192-1930); Canungra (B.360198-1917); North Pine River, Petrie (B.210650-1932); Caboolture (B.360196-1955); Banana (C.107447-1961); Marlborough (B.360209-1956); Yatton Ck near Croydon (B.191925-1973); Port Mackay (B.360208-1873).

Surprisingly, no eggs were recovered from *A. quadripartita* within its distribution from Geraldton to Bunbury. Photographed egg specimens are stored at the South Australian Museum.

Discussion

This study has shown a wide distribution for *T. albocincta* (Egg Types 1 and 3), being more compatible with foodplant distribution. No evidence for its distribution was found in New South Wales or the montane areas of eastern Victoria. The revised distribution (Fig. 2) includes north-west Western Australia, central Australia, South Australia, north-west Victoria and central Queensland. It includes Barrow Island in Western Australia and Kangaroo Island in South Australia. It is likely to occur also in western New South Wales and along the southern coast of Victoria, based on foodplant distribution and general habitat data.

The lack of adult records in Queensland and New South Wales is unusual considering the large number of lepidopterists in those states. The fact that *Adriana* is considered to be a poisonous weed by eastern state farmers and eradicated on sight may be one reason. Confusion in the field between *T. albocincta* and *Theclinesthes serpentata* (Herrich-Schaffer) may be another.

The distribution of *T. h. littoralis* (Egg Type 2) has been extended west from Esperance to the Albany area. The small area of distribution of *A. quadripartita* in south-west Western Australia poses a conservation problem for *T. hesperia* in the future.

Interestingly, the *Adriana* distribution exhibits well defined concentrations in different parts of Australia and the available records of *T. albocincta* adult butterflies suggest there may also be endemic varietal populations of *T. albocincta* associated with these different *Adriana* concentrations. In the

north-west of Western Australia the *T. albocincta* Form 4 (Sibatani and Grund 1978) is associated with a concentration of *A. tomentosa*. In southern South Australia the *T. albocincta* Form 3 is associated with *A. klotzschii*. In central Australia the *T. albocincta* Form 2 is associated with *A. hookeri*. The north-west Victoria population of *T. albocincta* on *A. hookeri* may also belong to this group. In central Queensland the *T. albocincta* Form 1 is associated with *A. glabrata*. The eggs of Forms 2, 3 and 4 are indistinguishable from each other. Egg Type 3, probably associated with the lectotype of *T. albocincta*, is quite distinct and may ultimately indicate that populations with Egg Type 1 belong to a different species.

The strongly different Egg Type 4, which is not associated with any *T. albocincta* adult butterfly records, has prompted lepidopterists to suggest that other lycaenid species are also involved in egg laying on *Adriana*, particularly the closely related *T. serpentata* and *Theclinesthes miskini miskini* (T.P. Lucas). The foodplants for the latter two species, respectively Chenopodiaceae and Leguminosae/Mimosoideae in South Australia, and for *T. albocincta* often grow side by side in the field and, in the author's experience after rearing a large number of *T. albocincta*, these butterflies do not use each other's foodplants. With this in mind further experimentation and a close look at the life histories of the other *Theclinesthes* species was undertaken.

The egg of *T. s. serpentata* in South Australia (Fisher 1978, p.223) is similar to that of *T. albocincta* (Egg Type 1, also Fisher 1978, p.220) but differs in that the intra-reticulation area is smaller and often irregular and the processes are markedly reduced. Larvae of *T. serpentata* would not eat any part of *A. klotzschii* at any stage of instar development.

The egg of *T. m. miskini* (Fisher 1978, p.218) is similar to that of *T. serpentata*, except the reticulated pattern is more regular and the processes are better developed but still not as developed as in *T. albocincta*. First instar larvae would accept the yellow male stamens of *A. klotzschii* and attained about the third or early fourth instar before death.

Whilst revising this paper the author encountered a second instar larva of *Nacaduba biocellata biocellata* (C. & R. Felder) on a male flower spike of *A. klotzschii*, collected during a vegetation survey in southern Eyre Peninsula, but unfortunately could not verify if the larva had translocated from the blossom of *Acacia anceps* DC. during the course of the field collection. This larva continued to eat the yellow stamens of the male *Adriana* flowers and finally pupated, but unfortunately was parasitized. Immature *N. biocellata* larvae were then experimentally introduced to male *Adriana* flowers and one larva was eventually reared which pupated normally and emerged as a perfect female. The author has examined hundreds of *A. klotzschii* both before and after these experiments and has never encountered *N. biocellata* either in the egg or larval stage, although adult butterflies occasionally use the *Adriana* flowers and nectary glands for feeding and it is therefore possible an

occasional female may lay eggs on the open male blossom, especially if there is ant activity. The egg of *N. biocellata* is slightly smaller than that of *T. albocincta* and, although the reticulated pattern is coarse like *T. albocincta*, the pattern differs by being distinctly hexagonal. The reticulation intersections are not raised.

Further collecting of adults and immature stages is required to confirm that the distibutions of *T. albocincta* and *T. hesperia* are more extensive, particularly in tropical and eastern coastal areas for *T. albocincta* and in south-west Western Australia. Further examination of the taxonomic relationship between *T. albocincta*, *T. h. hesperia* and *T. h. littoralis* is also required. Live material of all the forms and variants of both species is required by the South Australian Museum so that allozyme studies can be undertaken.

Acknowledgments

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